Space Weather Technical Forecast

Issued on Thursday, 02 March 2023 at 12:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Likelihood of M-class flares, with slight chance of X-flares. Increasing risk of G1/Minor Storms through the period. Active fluence declining later in the period.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity is Low, with a C9 flare peaking at 02/0450 UTC from AR3234 in the northwest. This is the largest and most complex region on the disc, with a couple of small delta spots. Other regions currently appear small and simple, although there are three near the east limb which are still difficult to analyse due to foreshortening effects and these may be more complex than their current classification. A C4.2 flare from AR3236 in the southwest at around 01/1330UTC appears to be the source of a CME which may give a glancing blow at Earth overnight from 04-05 March, but is much more likely to miss.

Solar Wind / Geomagnetic Activity: Solar wind speeds as observed at L1 by DSCOVR and ACE, have shown waning High Speed Stream (HSS) effects from CH79. Wind speed eased from around 600 km/s to near 500 km/s. Density has been mostly average or just slightly above. Total IMF, Bt, has been weak at 7nT or below, with the north-south component, Bz, varying weakly. The phi angle started positive (away from the Sun) but became variable from 01/2200 UTC. Geomagnetic activity has been Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 is at background levels. Electron flux has mostly been above the high threshold, peaking at 3.73e3pfu at 01/1900UTC. Electron fluence has been following a rising trend but is now steady above the Active threshold, with 1.8e8 integrated pfu observed at 02/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Low to Moderate activity is expected with a slight chance of Strong activity, mainly from AR3234 in the northwest quadrant.

Solar Wind / Geomagnetic Activity: No CMEs are forecast, but there is a very low risk of a glancing blow at Earth overnight from 04-05 March. The high speed stream from coronal hole 79 is currently weakening and effects should continue to ease through Day 1 (02 Mar). Further high speed stream effects are possible from Day 2, becoming increasingly likely later in the period. There is some uncertainty in the forecast, but wind speeds are likely to be at elevated or slightly elevated levels through much of this period, perhaps becoming strong on Day 4 (05 Mar). These coronal holes are negative polarity, which is more favoured for geomagnetic response near the March equinox.
Geomagnetic activity is expected to be mainly Quiet through Day 1, perhaps reaching Unsettled to Active levels through Day 2 (03 Mar), and then with an increasing risk of G1/Minor Storm intervals through Days 3 and 4.

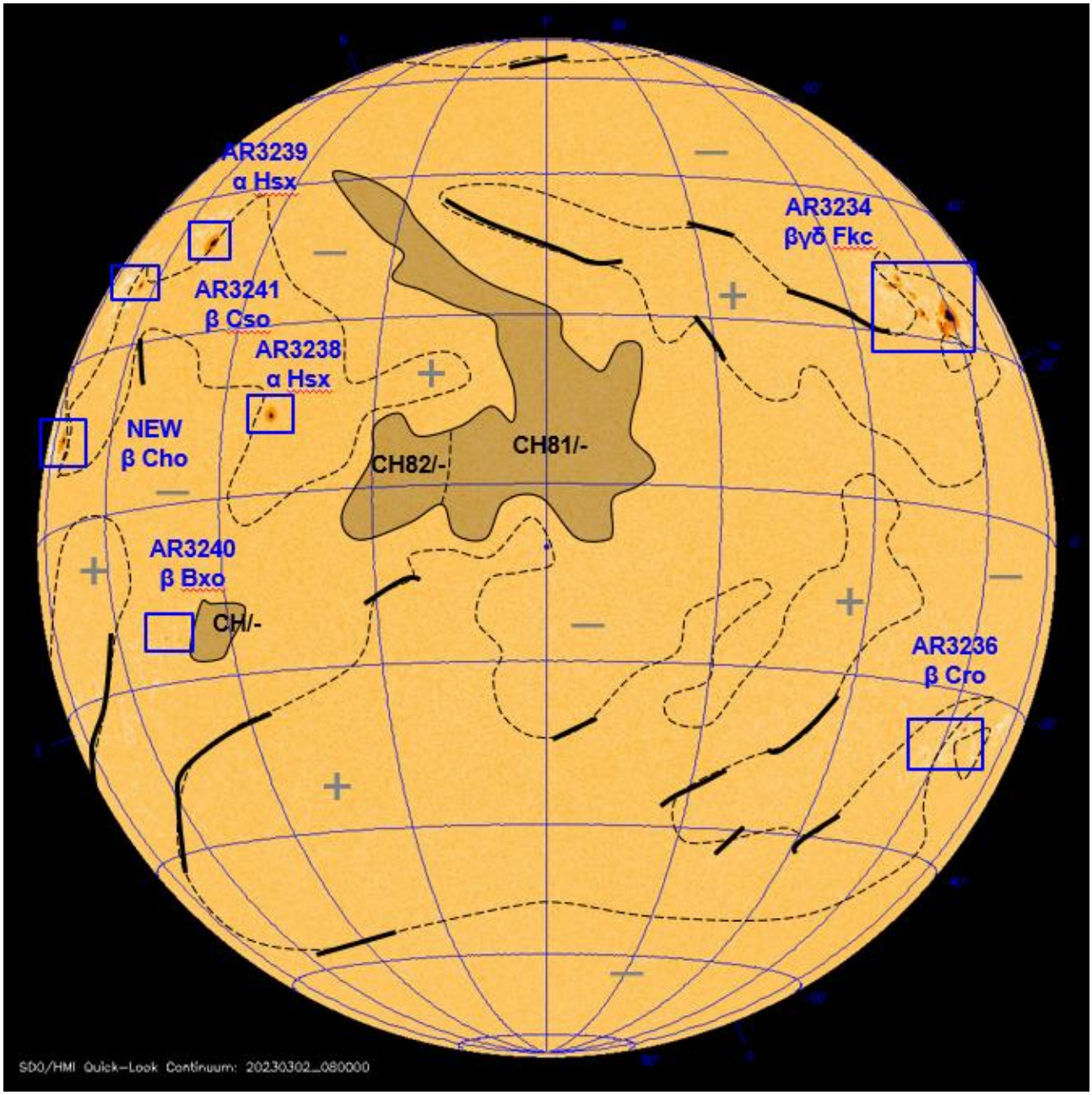
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 2MeV) is at background levels with a slight chance of S1/Minor Storms, mainly from AR3234. Electron flux is

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

expected to remain above the high level at first, perhaps with an increase in the near term, before likely declining later in the period. Electron fluence is currently above the Active (1e8 integrated pfu) level, likely reducing later in the period.

Figure 1. Solar Analysis Valid 02/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

No CMEs are forecast, but an eruption from the southwest around 01/1330UTC has a very low risk of giving a glance at Earth overnight from 04-05 March.

The high speed stream from coronal hole 79 is currently weakening and effects should continue to ease through Day 1 (02 Mar). A further high speed stream from coronal holes 81 and 82 is likely to occur later in the period. It looks similar in location to the previous rotation but perhaps a little stronger. Last time around the HSS arrived on the equivalent of Day 4 (05 Mar). However, solar wind data at STEREO-A suggests that a HSS has arrived there within the last 24 hours; this matches Enlil's prediction that wind speeds will start to increase once again at Earth during Day 2 (03 Mar). This is unlikely to be from CH81, but there may be an obscured coronal hole which is not clearly visible in imagery causing this increase. As such there is some uncertainty in the forecast, but wind speeds are likely to be at elevated or slightly elevated levels through much of this period, perhaps becoming strong on Day 4. These coronal holes are negative polarity, which is more favoured for geomagnetic response near the March equinox.

Geomagnetic activity is expected to be mainly Quiet through Day 1, perhaps reaching Unsettled to Active levels through Day 2 and then with an increasing risk of G1/Minor Storm intervals through Days 3 and 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	10	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

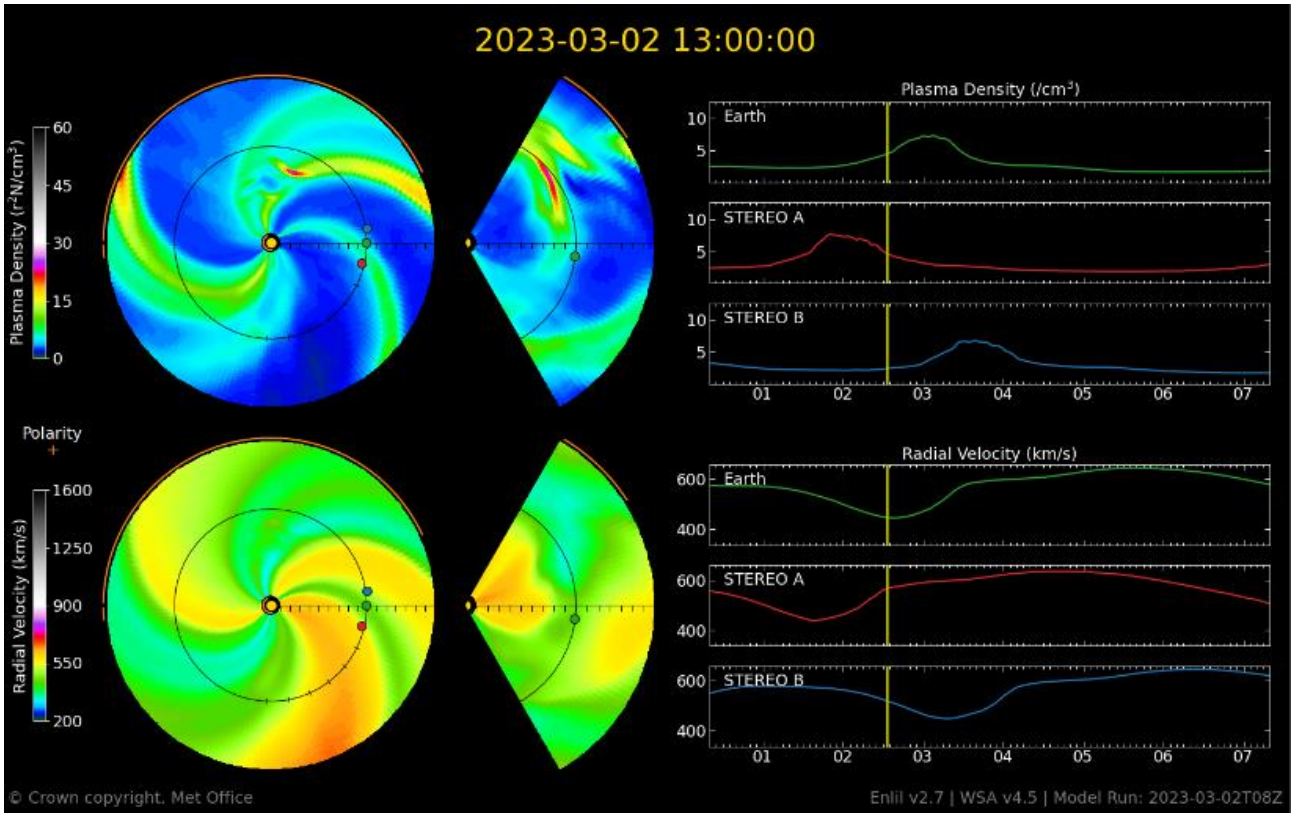
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2: MOSWOC Enlil, which is suggesting an increase in wind speed through Day 2, with a further increase later in the period.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

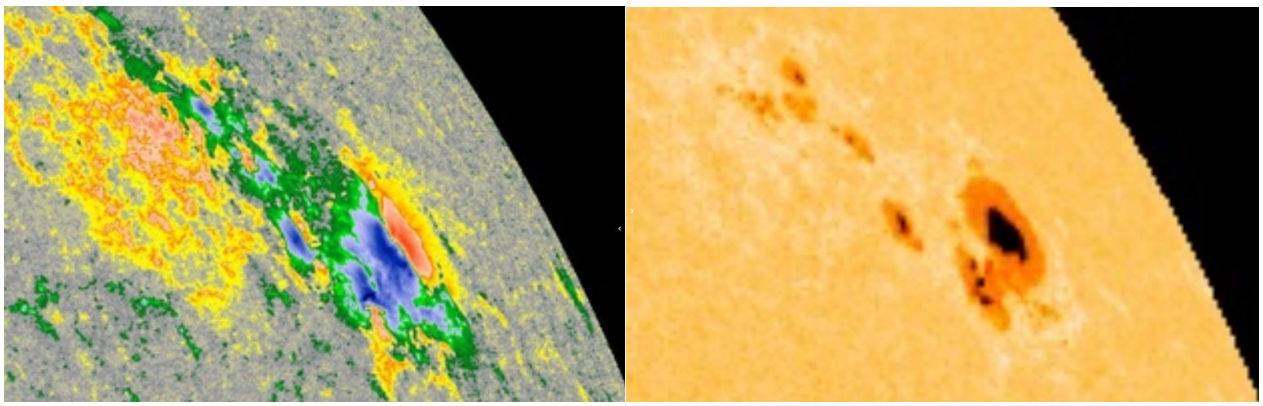
© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
AR3234 in the northwest is the largest and most complex region on the disc, with a couple of small delta regions remaining in the intermediate spots. AR3240 in the southeast, despite appearing weak, has produced a high energy C-class flare but is now appearing to fade. Three new regions have rotated onto the visible disc from the far side in the last 24 hours. The viewing angle makes a detailed diagnosis of the structure and complexity of these regions difficult, but they appear to be associated with large areas of magnetic flux, and may be more complex than their current classification. Far side seismographs suggest that further regions are likely to rotate on in the coming days.

Solar activity is expected to be mainly Low to Moderate, with a slight chance of Strong activity.

X Ray Flares / Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 3: AR3234, which is still showing a couple of small delta regions despite now starting to approach the limb with foreshortening effects beginning to make assessment more difficult.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels. Although no significant flares have been observed recently, the position and complexity of AR3234 presents a risk of proton rich flares, with a continuing slight chance of S1 through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

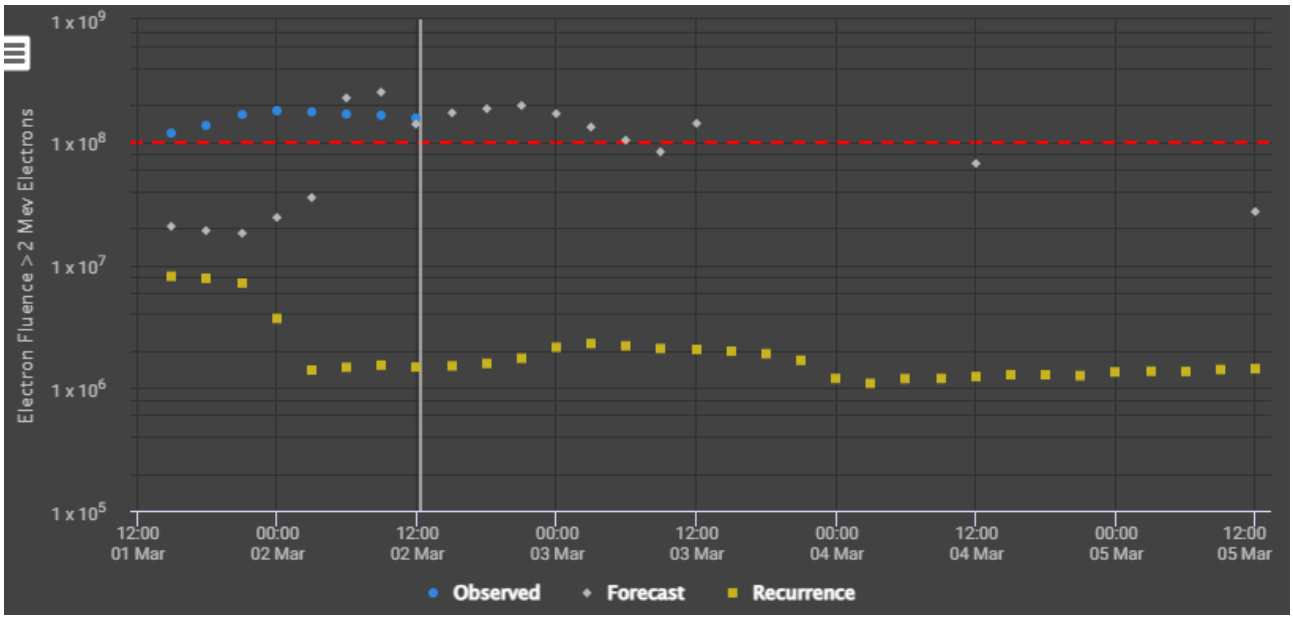
© Crown Copyright 2023. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is at high levels and is expected to remain similar at first. It seems likely that significant charging has occurred in the radiation belt which is probably still compressed below GEO by the HSS. As the HSS eases through the next 24 hours, a further increase in flux levels is possible in the short term. A decline is then possible later in the period, due to the effects of a further high speed stream and associated increased geomagnetic activity. We may start to see a return to high levels at the very end of the period, but more likely after the end of this period.

Electron fluence values are expected to remain above the Active (1e8 integrated pfu) level at first, perhaps rising further in the near term, before declining later in the period due to the forecast high speed stream onset. MOSWOC REFM is suggesting a gradual decline below Active, which is not unreasonable, although confidence is only moderate in the timing of this.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	60	50
Very Active	≥ 2 MeV ≥ $1x10^9$	No	10	10	10	5

Figure 4: MOSWOC REFM showing a gradual decline in fluence levels.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.